

# **Knowledge/Data Mining, Assessment and Forecasting of Ground Military Vehicle Technologies**

## **Key-Note Speech**

by

Ramki Iyer

 Ramki.iyer@us.army.mil

 011-91-5862826047

Team Leader, NAC/TARDEC – US Army

@

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# Key-Note Speech's Outline

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- National Automotive Center (NAC) & Tank Automotive Research, Development and Engineering Center (TARDEC) Relationship.
- NAC/TARDECs Technology Thrust Areas
- R & D funding decisions should be based on a thorough scientific analyses of world-wide research in several scientific disciplines.
- Robotics Case-Study
- Innovation required when a solution to a technical requirement adversely affects another.
- Inventive Principles with many examples.
- My Personal Innovations & Thrills

# **Key-Note Speech's Outline (Continued)**

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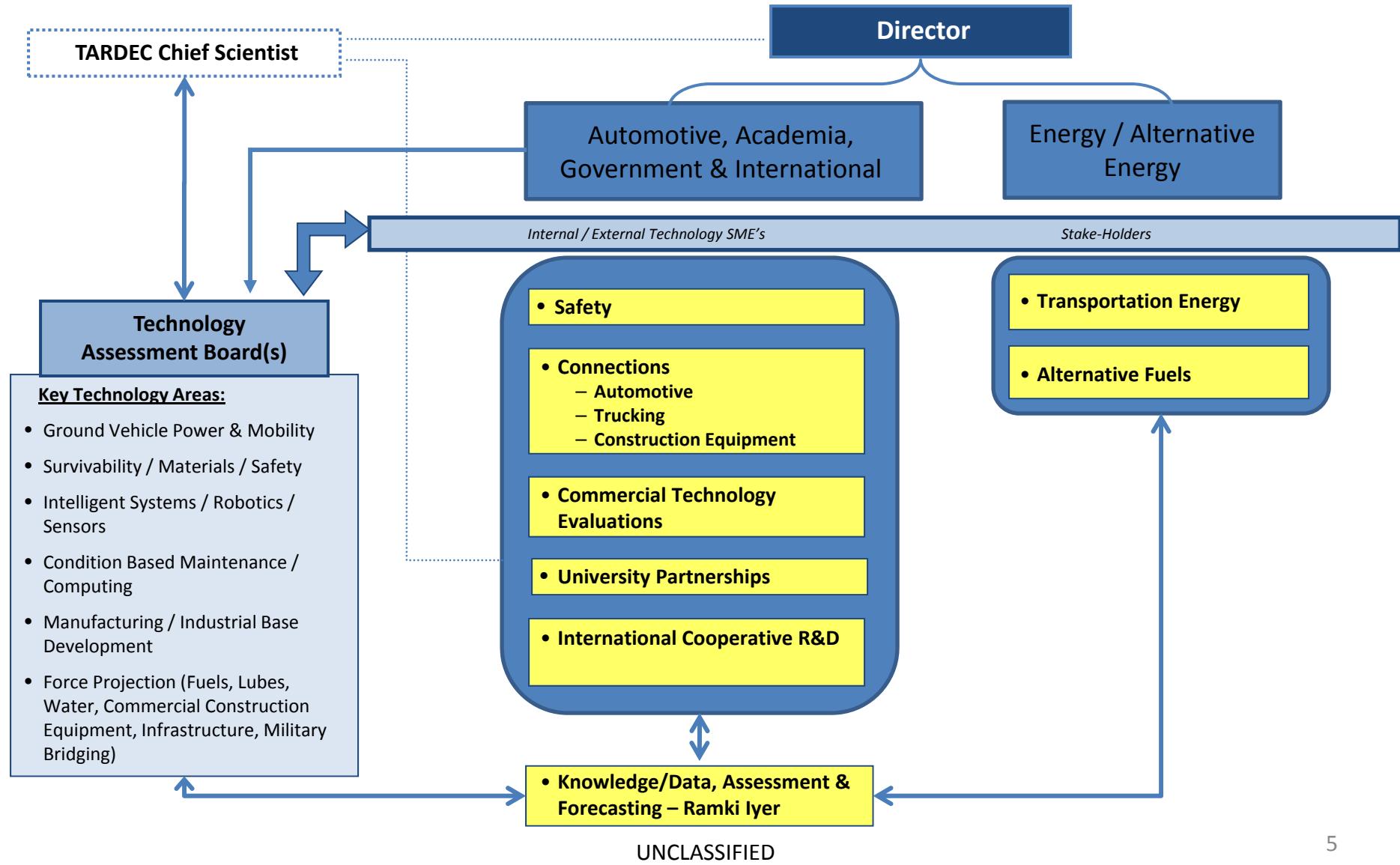
- Challenges to Mine, Assess and Forecast Technology - Information Overload.
- Methods to Mine, Assess and Forecast Technology
  - DELPHI
  - Software
- NACs Strategic Plan to implement Mine, Assess & Forecast Technologies.
  - Combination of Delphi & Software Approaches
  - Technology Assessment Boards (TABs)
- TAB Case Study for Miniaturized Superconducting Antenna
- Knowledge Mining, Assessment and Forecasting Implementation Challenges.
- Mitigation Strategies to overcome Implementation Challenges
- Current Status
- Questions

# **NAC – TARDEC Relationship**

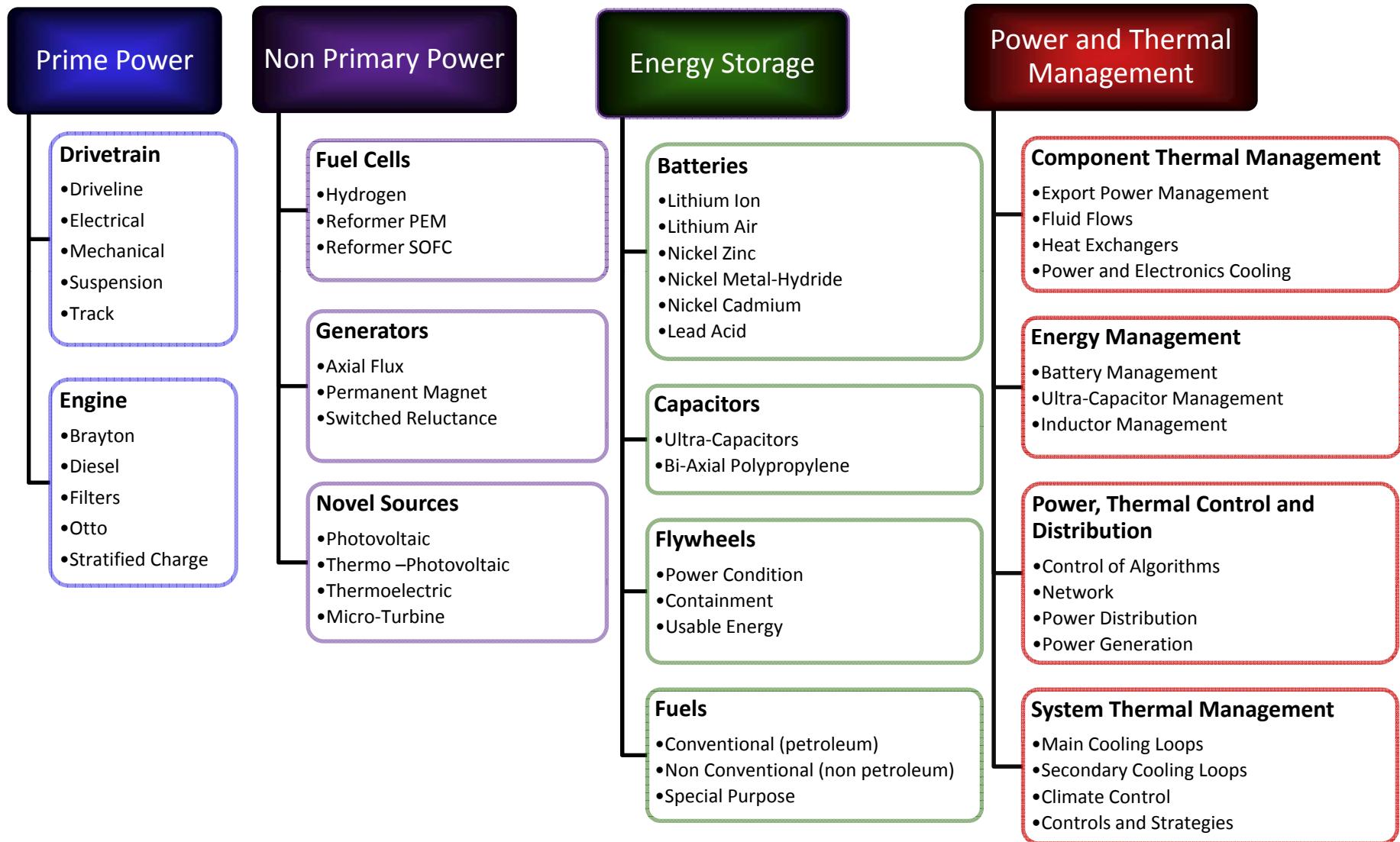
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***NAC is the window between TARDEC and  
World-wide Industry / Academia for  
Thrust Technologies of benefit to the  
War-fighter and the Commercial World.***

# NAC-TARDECs Technology Thrust Areas



# Power and Energy Technology Thrust Area's Taxonomy



# R & D Funding needs to be based on thorough World-wide Analyses of Information

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- Army's Requirement
  - Gadget to defuse bombs in multi-storied buildings
- Scientist John Doe proposes an obvious solution
  - 4 Legged robot with the capability of
  - Video Camera
  - Chemical/Biological Sensors
  - Climbing, Turning & Collision Avoiding Capabilities; etc.
- Funding Sought - \$4m across 4 years
- Should the above project be funded?
  - No, for the time being, since enough base-line research not conducted

# R & D Funding needs to be based on thorough World-wide Analyses of Information

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- Recall network news 2 or 3 years ago
  - China had developed a 2-legged robot to deliver beverages as desired by patients
  - 2-legged robot apparently comprised
  - Kinematics, Control System, Electronics, Power, etc.
  - Recent research in exo-skeleton sensors exploited Micro-Electro Mechanical Sensors (MEMS)
- Above technologies can be adapted for the bomb de-fusing application by collaborating with China
- Also use the MEMS concept

# R & D Funding needs to be based on thorough World-wide Analyses of Information

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- **Result**

- Reduced development risk
- Reduced development time & cost
- Frees up valuable \$s for other research
- Win-Win Situation

- **Collaboration**

- Promotes **Innovation**
- Achieves a balance between opposing ideals of **social community and free enterprise**

# Innovation Challenges

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## *Information Explosion:*



- Over 1,000 World-wide R & D Databases in different languages
- Over 33 million+ patents
- Conclusion
  - Innovation Required

# Innovation Required despite Information Explosion

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- **Technical problem**
  - Requirement
    - More payload carrying capacity on vehicle
  - Obvious Solution
    - Increase section thickness
- **Result**
  - Increased vehicle weight adversely affects mobility
- **Required Approach**
  - Out-of-the-box thinking required to innovate
  - Solution in one scientific area solves a problem in another

# Innovation Required despite Information Explosion

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- **Innovative Solution Example**
  - Army Tank's Turbine engine's Metal Blades pitting due to operation in the desert
  - Apparent thought – Use ceramics that are extensively used in armor
  - Armor Ceramics – thick, heavy, joining problem with metal
- Thermal spray ceramics manufacturing of **micro-electronics** industry successfully solved the blade pitting problem – Excellent adhesion properties of thin films
- **Conclusion**
  - Current problems in one scientific area easily solvable by applying concept used in another

# Theory of Inventive Solutions - Motivation

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- Recurrent problems & solutions across sciences
- Recurrent technology evolution patterns
- Innovation in one technology inspired from another
- Conclusion
  - Out-of-the-box thinking required to innovate
  - Solution in one science area solves a problem in another
  - Turbine blade pitting problem - one example

# Theory of Inventive Solutions

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- Another Example
  - Field curing of polymer composites using paramagnetic heating characteristics of embedded ferro-magnetic nano-powders
    - Accomplishes controlled field curing compared to induction heating
  - Out-of-the-box thinking – Use paramagnetic properties to only kill cancerous cells

*Theory of Inventive reasoning motivates out-of-the-box thinking to deduce solutions*

# **Some Principles that Motivate Innovative Thinking**

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## **1. Partition**

- Project work break down structure
- Drawings from overall assembly to components to parts
- Net-worked PCs versus Super-Computers
- Modular military bridges

## **2. Removal**

- Extract infected tooth to avoid spreading infection
- Electrical fuse
- Structural fuse
- Inexpensive and easy to replace component
  - Use weaker material so a component fails before critical failure of system.
  - Easier to replace a fuse, than to replace a system

# **Some Principles that Motivate Innovative Thinking (Continued)**

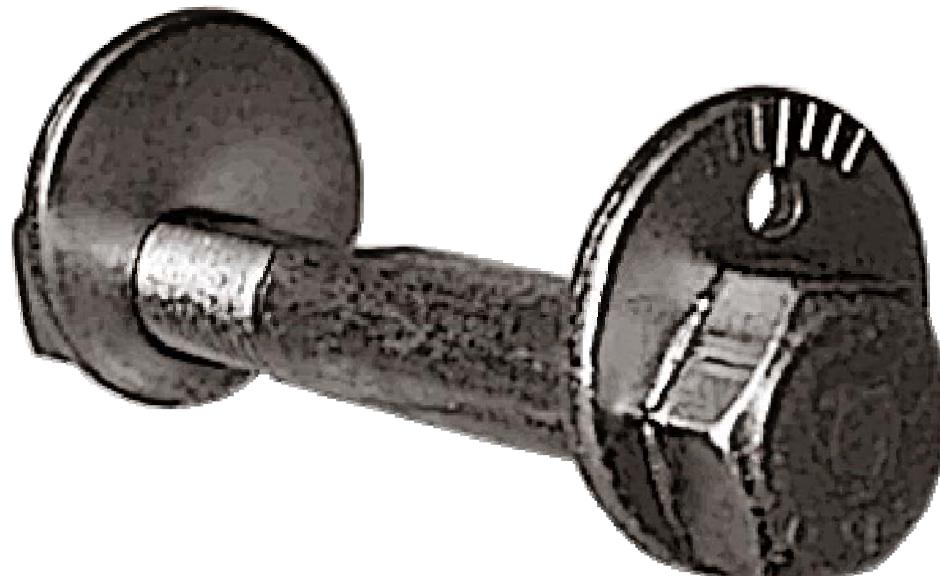
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## **3. Change Macro/Micro Compositions**

- Orthotropy / Anisotropy instead of Isotropy
  - Polymer composites with oriented carbon, glass, metal fibers instead of only metals
    - Reduced Weight

## **4. Asymmetry**

- Eccentric Bolt



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# Some Principles that Motivate Innovative Thinking (Continued)

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## 5. Integration

- Peer-to-Peer (P2P) Networking Protocol
  - Direct connection to PCs across the world using the internet
  - Provides increased computing power – avoids costly ownership of a data processing center

## 6. Universality

- One size fastener in a military system
  - Results in volume procurement price discount
  - Ability to retain a smaller inventory stock

## 7. Nesting (Matryoshka)

- Nested Dolls – Inspires children, *even me!! 😊*
- Telescoping cranes, Mobile Antennae, Mobile Missile Launcher



# Some Principles that Motivate Innovative Thinking (Continued)

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## 8. Counter-moment

- To resist large lateral deflection of earth-quake forces in multi-story buildings – Japan's success.
- To mechanically launch/retrieve military bridge

## 9. Prior Anti-Action

- Pre-stressed Concrete
- Lead Apron – X-ray
- Health Care – Yearly Physical

## 10. Pre-action

- Partially cured prepreg
- Assembly line manufacture for automobiles inspired by the watch making industry.
- Sterilized medical instruments

# **Some Principles that Motivate Innovative Thinking (Continued)**

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## **11. Energy Absorption**

- Seat-Belts in automobiles, aircraft
- Air-bags in automobiles
- Helmets and armor
- Principle
  - Energy = Load \* Displacement
  - Small Load  $\Rightarrow$  Large Displacement
  - Large Load  $\Rightarrow$  Small Displacement

## **12. Uniform Potential**

- To reduce load to lift / lower - Pulleys
- Rollers on luggage
- Rollerblading to work

# **Some Principles that Motivate Innovative Thinking (Continued)**

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## **13. Invert the process**

- Pultruded polymer composites instead of extrusion as used in Al
- Heat treat fabricated aluminum structure in annealed condition instead of heat treat components prior to assembly fabrication.

## **14. Curvature instead of flat**

- Arch structure induces in-plane and not out-of-plane forces
- Geodesic dome – R. Buckminster Fuller, Inventor
- Umbrella Design – change to hemisphere to a small plastic window to enable the ability to see and also use in rain/sun.  
(My innovation when I was 18 years old - my friends shot it down).

## **15. Partial Solution**

- Classic approach in risk management of technology
  - 70% solution today is better than the delayed 100% solution
- Software Patches very common
  - Increased universal usage improves product compared to limited beta-testing.

# **Some Principles that Motivate Innovative Thinking (Continued)**

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## **16. Add Dimension**

- Multi-CD player placed in vehicles, versus a single CD player
- 7.1 surround sound versus 2.0 stereo system
- Apartment buildings versus single-family homes
- 64bit CPU processors versus 32bit processors, depending on application.

## **17. Vibration**

- Vibrating shaving razor blade
- Electric carving knife with vibrating blade
- Vibrating tooth brush
- Reclining chair with variable vibration speeds

## **18. Periodic Action**

- How real is real time?... Nano-second, micro-second, etc.
- In structural health, should it be monitored
  - Once a day or immediately alert of failure
- Health Care – Emergency call button

# **Some Principles that Motivate Innovative Thinking (Continued)**

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## **19. Continuity of activities**

- CPM / PERT network for a project has activities on critical path and others not on the critical path.
- Activities on critical path do not have float
- Move resources of activities from non-critical path to those on the critical path.
- Condition Based Maintenance (CBM)
  - System redundancy with two controllers operating in parallel
  - If one controller fails, the second controller is fully capable of seamlessly receiving control.

## **20. Waste management for useful production**

- Dung to generate Methane
- Human Urine to potable water

# **Some Principles that Motivate Innovative Thinking (Continued)**

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## **21. Reverse Action**

- Magnetostrictive materials traditionally used as robotic actuator
  - Applied electro-magnetic field translates to a mechanical force
- Conceived a concept to powderize magnetostrictive rods and introduce them into a slurry, to monitor fatigue cracks – Acts as a sensor.

## **22. Skipping**

- Friction stir welding almost eliminates HAZ (no electrode)
- Water-jet cutting

## **23. Feedback – Cross Check**

- Amend management measure from budget variance to customer satisfaction.

# **Some Principles that Motivate Innovative Thinking (Continued)**

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## **24. Intermediate Steps**

- Dabbas (Food Containers) change multiple hands in reliable supply chain

## **25. Self-Service**

- Pumping gas – reduces cost
- Buffet concept
- Toll-paying – Traffic moves fast
- Money in buses - eliminates the conductor

## **26. Mimicking (Replicate Process)**

- Video conferencing – reduces cost
- Satellite imaging instead of ground survey

# **Some Principles that Motivate Innovative Thinking (Continued)**

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## **27. Short living / Degradation**

- Recycle paper, cans, diapers
- Compost

## **28. Exploit physics**

- Control heat of resin curing through embedded ferro-magnetic particles, instead of non-controllable induction heating.
- Use of high-frequency sound waves, to keep dogs away versus using a physical fence.

## **29. Use pneumatics/hydraulics instead of solids**

- Shoe in-soles with silicon padding
- Airbags in automobiles
- Inflatable structures – tents, fortification, Mars Pathfinder spacecraft.

# **Some Principles that Motivate Innovative Thinking (Continued)**

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## **30. Flexible shields and thin film**

- Reconfigurable aircraft wing to reduce drag - Morphing
- Use shape memory alloys, polymers, miniature hydraulics

## **31. Porous Materials**

- Drill holes in solid to reduce weight
- Aerate lawn to improve growth
- Cigarette Filters
- Store water in mud pots to keep it cold, if no refrigeration
- Mosquito nets to enable breathing

## **32. Chameleon - Principle of changing color**

- Litmus paper
- Changing color of soldier uniform – Commercial T-shirts
- Energy saving bulbs change low to bright light over time

# **Some Principles that Motivate Innovative Thinking (Continued)**

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## **33. Homogeneity**

- Polymer composites fabrication with chopped strand mat reinforcement yields light weight, isotropic properties.
- Nano-material embedded composites – a hot research topic, e.g. clay for fire resistance, carbon nano-tubes for strength/stiffness.
- Make a diamond cutting tool using diamonds

## **34. Discard and recover**

- Design portions of an object that are discarded after its function is fulfilled.
- Antibiotics in dissolving, but a benign capsule
- Dunk noodles from boiling water into cold water
  - To avoid over-cooking
  - To remove the excess starch

# **Some Principles that Motivate Innovative Thinking (Continued)**

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## **35. Change physical state**

- Shape Memory Alloys (SMA) change from Martensitic to Austenitic condition and shape at transition temperature – Application: fasteners.
- Shape Memory Polymers (SMP)
  - Energy absorbing fasteners
- Heat ferro-magnetic particles through a magnetic field to a paramagnetic constant state temperature instead of non-controllable induction heating.

## **36. Exploit Phase Transition**

- SMA and SMP
- Award contracts in increments to reduce risks
- Hannibal, when attacking Rome, poured water over huge blocking rocks at night that broke into small pieces due to freezing phenomenon.

# **Some Principles that Motivate Innovative Thinking (Continued)**

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## **37. Thermal Expansion**

- SMA joints to join pipeline segments – No thread machining

## **38. Strong Oxidants**

- Hyper-baric Chamber
  - Decompression for hit air force pilots
  - Recompression for underwater divers
  - To cure cancer affected mouth
  - To aid healing process in severely burned patients

## **39. Inert Environment**

- Use argon/helium environment to prevent Al. Oxidation while welding.

## **40. Composite Materials**

- Infrastructure – Bridge Decks
  - Carbon instead of steel reinforcement to avoid corrosion problem
  - Wrap-around reinforced concrete pier to resist seismic failure
  - Military composite bridges



COMPOSITE  
ARMY  
BRIDGE

# **Some Principles that Motivate Innovative Thinking (Continued)**

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- Just finished giving Multi-disciplinary examples of innovation principles
- Think out-of-the-box for innovation

***Let us now think:***

- Beyond the principles presented
- Personal past innovations

# Beyond the Theory of Inventive Reasoning

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*Exploit material phenomenon*

## Innovation:

- Use shape memory trained alloy insert
- Under transition temperature
  - Insert behaves as a Martensitic passive damper (huge elongation)
  - When temperature increases to transition temperature
  - Changes SMA to Austenitic phase
    - huge strength/stiffness increase
  - Insert wants to change shape but is prevented due to locking torque.
- Result: Smart Fastener
  - So think **BEYOND** the principles of the Theory of Inventive reasoning presented

# Beyond the Theory of Inventive Reasoning

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- Many times innovation is through serendipity
  - SMA insert in fastener always split while machining
  - Behaved better after the break – Increased energy absorption
- Serendipity element in finite element analysis

# Beyond the Theory of Inventive Reasoning

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- Observe around, with the problem to be solved in mind
  - Rail/Wagons assembly process during shunting
  - Motivated me to conceive and implement an automatic tension resistant locking joint for military bridge while being cantilever launched.

# Beyond the Theory of Inventive Reasoning

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- Stand on others' shoulders to better scientific discoveries
  - A physicist friend of mine showed me a Scanning Electron Micrograph of some conical growths with whiskers on plasma subjected solid graphite.
  - I conceived the idea to use the above phenomenon to develop growths on carbon fibers, mats – Buckytubes.
    - Improved intra and interlaminar strength and stiffness properties, especially compression.

# Beyond the Theory of Inventive Reasoning

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- Collaborate / share your knowledge with others
  - My carbon buckytube when shared with Prof. Thomas Hahn a stalwart in composites for the last 50 years (I met him 20 years ago).
  - Ramki: “In all my 25+ years, have never seen as innovation like yours. Incidentally, it also improves transverse intra and interlaminar thermal **conductivity** problem.

# Beyond the Theory of Inventive Reasoning

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- Exactly understand what is to be gleaned
  - Humongous data
    - Health monitoring of vehicles, infrastructure, humans.
    - Frequently used phrase:  
**“Accurately and Reliably monitor in real-time.”**

*Issues:*

- “Accurately and reliably monitor”
  - How accurate is accurate?
  - How reliable is reliable?
- Monitor in real-time
  - Is real-time a nanosecond, microsecond, etc?

# Beyond the Theory of Inventive Reasoning

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- Approach to thinking and finding a solution
  - Accurate and Reliable
    - Compare experimental results with modeling and simulation predictions to assess accuracy and reliability.
  - Real-time
    - Motivation for solution  $\Rightarrow$  Bandwidth, Analysis
    - For an aircraft, ship, bridge
      - Set benchmarks for structural safety
      - Do not care if threshold not exceeded
      - Require data transmission once / day, is if no problem but immediately if a problem occurs.

# Beyond the Theory of Inventive Reasoning

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- Health of human beings, health care innovation
  - Aging human seniors with problems living alone, at their homes.
  - When they feel any concerned sign of discomfort (like chest-pain).
    - They press a button, that wirelessly calls their son/daughter at work via their cell phone.

# Beyond the Theory of Inventive Reasoning

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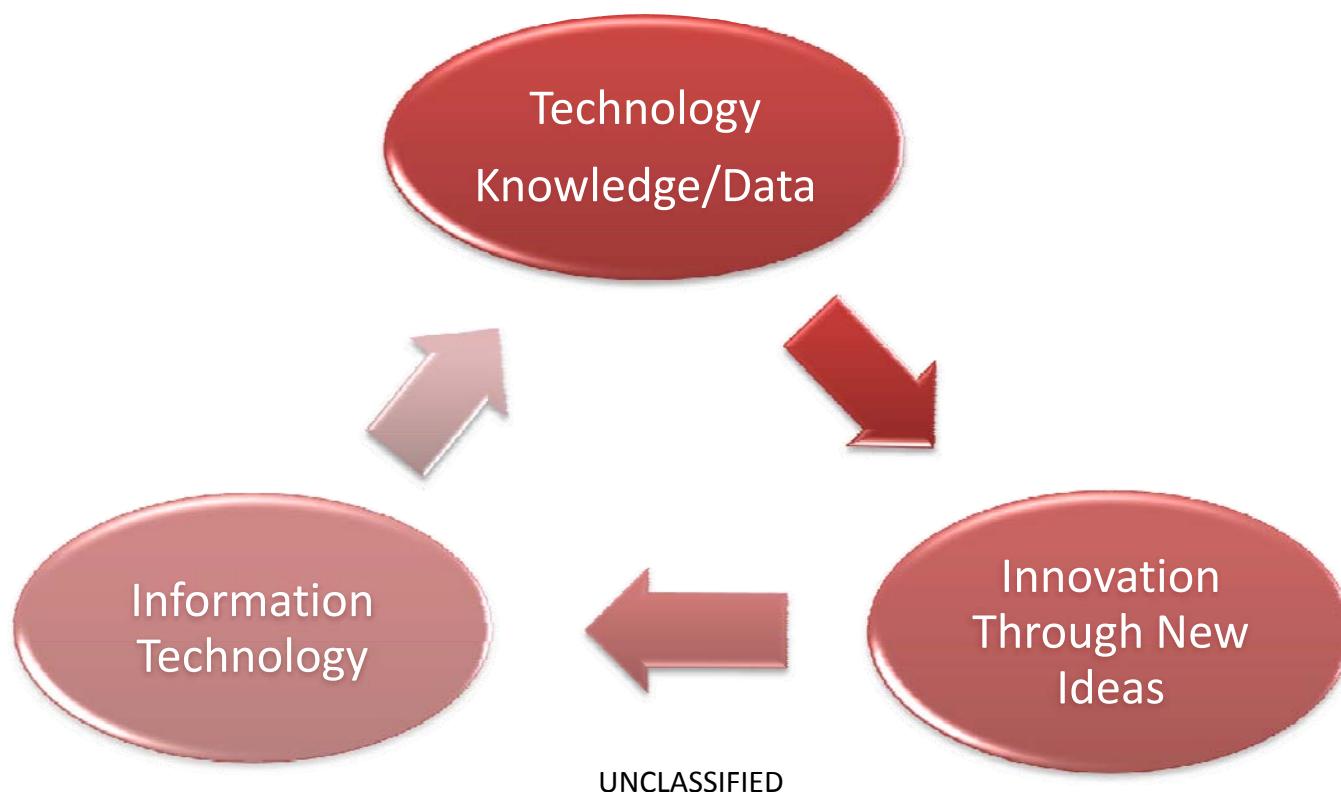
A fantastic world, that we live in – Is it not?

## Next Motivation:

- All said and done, beyond the inventive reasoning presented
- How do we tackle technological information overload at on organizational level?

# Technology Data/Knowledge Mining, Assessment, and Forecast Method

- DELPHI
- COTS Software Approach



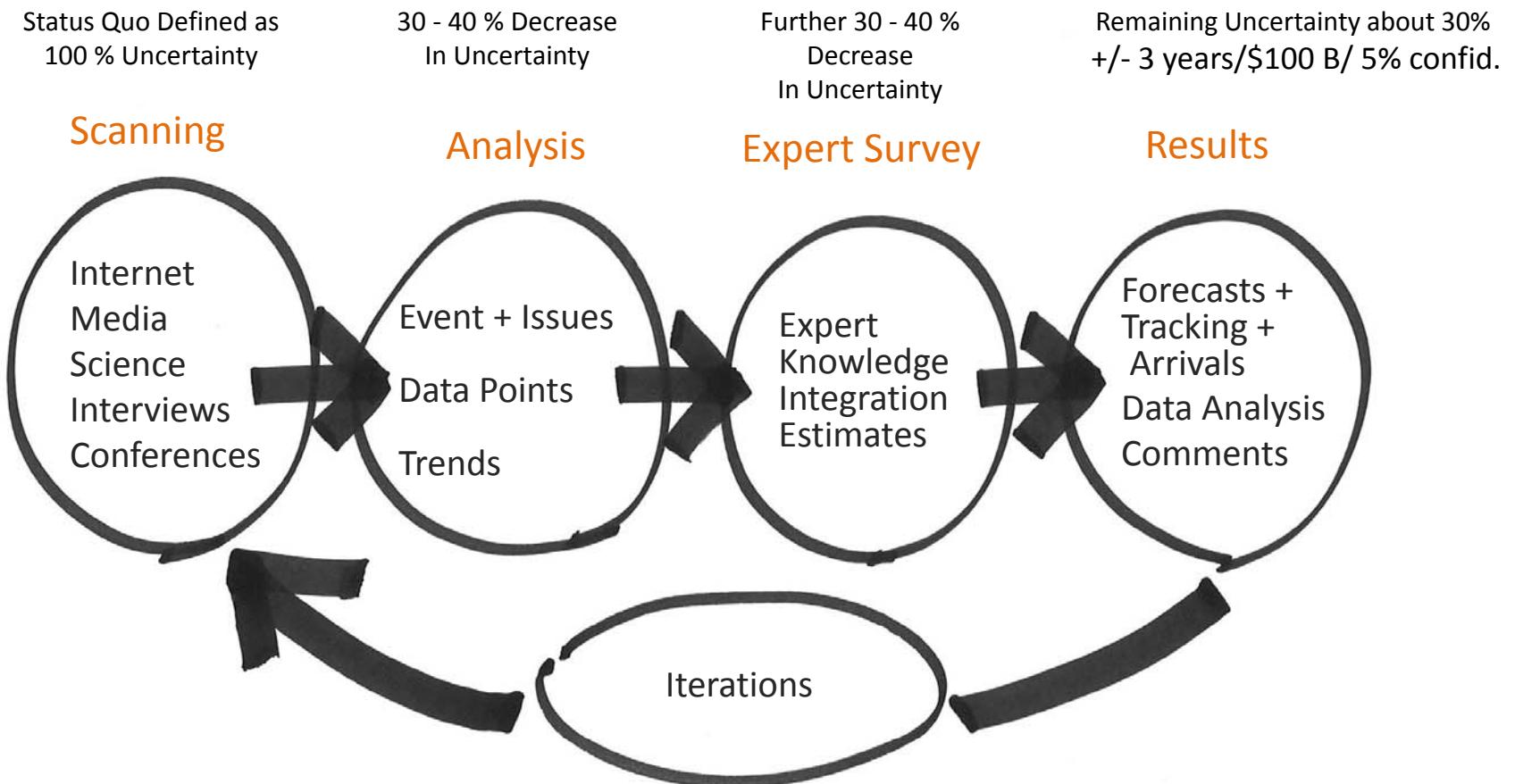
# Delphi Method

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- Group of experts' opinions sought on technologies
- Technology Examples
  - Fuel Cells
  - Transportation, including space travel
  - Nano-material
  - Cancer – Cure
  - Others
- The Interaction of Groups through the Internet Predict
  - Market Share - % Case, Maturation year
  - Technology Risks

# Flow Chart of Research Forecasting System

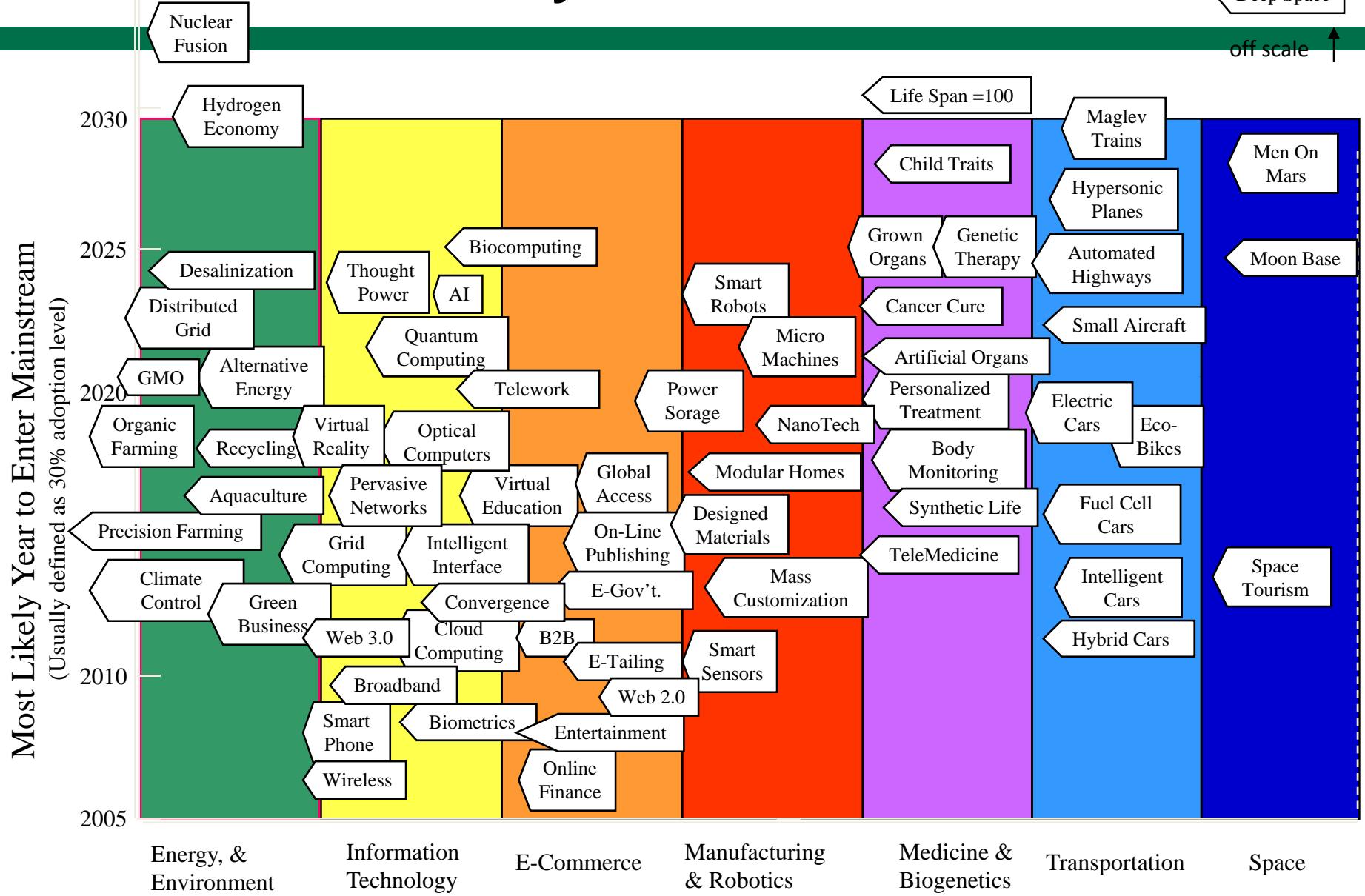
***"Best Possible Answers to Tough Questions"***



Acknowledgement – Dr. W. Halal

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# Summary of Forecast Results



Acknowledgement – Dr. W. Halal

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# **Delphi Method**

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- **Pros**

- Opinion of Experts – Human beings
- Larger the expert groups composition, opinions tend to even out biased opinions.

- **Cons**

- Requires extensive research effort by the group
- How does the expert group sift through multi-millions of references?
- Multi-Language Databases

# **Approach adopted to zoom into most appropriate Software**

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- Survey revealed availability of 32+ software
- Generated a Market Investigation Questionnaire seeking responses.
- Conferred with sibling Army Organization who were already using a knowledge mining search, COTS software.
- Released the Market Investigation Questionnaire to the world by telephone/Internet.
- Received 4 responses.

# Market Investigation Questionnaire

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- 32 Questions (partial list given) with 9 categories in total
  - Content Capabilities
  - Search / Navigational Capabilities
  - Semantic Validation
  - Language Capabilities
  - Assessment and Forecasting
  - Licensing
  - Customer Base
  - Technical Specifications
  - Training / Technical Support

# Market Investigation Questionnaire (continued)

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- Partial list of 32 questions
  - Does the software provide access to the relevant worldwide scientific databases?
  - Is the tool able to navigate and browse world-wide patent databases?
  - Is the tool able to automate failure mode effects analysis (FMEA) and to automatically search and retrieve indexed content that pertains to known failure modes, their effects and causes?

# Market Investigation Questionnaire (continued)

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- Partial list of 32 questions (continued)
  - Is the tool able to search, index and summarize data in English, German, Japanese and French?
  - What are the costs and various types licensing available?
  - Who uses your product for systems engineering or complex process/manufacturing technology?

# **Principles of & Approaches to Software Knowledge/Data Mining**

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- Advent of Artificial Intelligence and Natural Language Processing have yielded Technology Advances.
- Over the last 3 decades, evolved from Statistical to Semantic Knowledge Mining, Assessment and Forecasting Solutions.
- Primarily 2 Major Approaches
  - Pattern-Cluster Recognition of Data
  - Semantic Search Engine

# Principles of & Approaches to Software Knowledge/Data Mining

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## ■ Pattern Recognition

- Uses the Search Engine resident within the World-wide Science Databases.
- Through Refinement, pare down the number of applicable references.
- Import the References into the Knowledge/Data Mining Software for further Analyses through Pattern Recognition of Data Clusters.

## ■ Semantic Search Enables

- Use of Natural Language Queries from World-wide Knowledge/Databases.
- Identifies and generates **summaries** of the most relevant references.
- Serves as **Virtual Subject Matter Expert**
- Enables Science based Decisions for anything

# Comparison of Pattern Recognition Versus Semantic Search Software

Pattern Recognition	Semantic Search
<ul style="list-style-type: none"><li>- Requires structural text database, (e.g. Patent Records).</li><li>- Requires subscription to worldwide databases, costly.</li><li>- Need to know exact keywords for search.</li><li>- May not access multi-language databases.</li></ul>	<ul style="list-style-type: none"><li>- Accesses both structured and unstructured databases.</li><li>- Does not require actual subscription.</li><li>- Yields dynamic summaries and NOT abstracts.</li><li>- Accesses multi-language databases.</li><li>- Virtual SME</li><li>- Software helps to formulate the semantic search questions.</li></ul>

# Semantic Technology Software Architecture

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- Core Components Integration
  - Semantic Engine
  - Natural Language Processing
- Semantic Engine
  - Transforms information to an index of semantic terms
- User Queries via Natural Language Processing
  - Analyzed to compare user queries and source documents.

# Semantic Technology Software Steps

The screenshot shows a software application window titled "Researcher". The main area displays search results for the query "As Natural Language EN Ultracapacitors". A blue callout box labeled "Input for Semantic Searching" points to the search bar. The results are categorized into several sections:

- Definitions (200)**: third of storage device (16), supercapacitor (16), energy storage device (14), double layer capacitor (13), electrochemical capacitor (12), electrochemical capacitor b... (9), double-layer capacitor delive... (9), double-layer capacitor (8), electrolytic technology capa... (7), depending on application (6)
- More Specific (200)**: super ultracapacitor (98), internal ultracapacitor (42), high power density ultracapa... (37), capacitor (37), individual ultracapacitor (26), energy storage device (25), term "ultracapacitor" (24), HIGH PERFORMANCE UL... (20), electrochemical ultracapacitor (19), carbon-based ultracapacitor (19)
- Concepts (200)**: ultracapacitor bank (114), ultracapacitor's voltage (95), ultracapacitor cell (86), ultracapacitor pack (81), ultracapacitor electrode (66), ultracapacitor energy storage (55), ultracapacitor module (53), ultracapacitor technology (51), ultracapacitor system (45), ultracapacitor DC link (35)
- Advantages (127)**: more efficient than battery (6), rapid rechargeability (4), elimination of mechanical deg... (3), good cycle lifetime (3), useful for application (3), improvement of efficiency of o... (3), improvement of performance ... (3), allowing of SOC (3), high power capability (2), high power density (2)
- Disadvantages (19)**: typically more expensive than ... (6), more expensive than battery (3), loss of full charge in day (3), quite expensive around energ... (1), loss of system performance (1), tendency of electrode (1), too expensive by factor (1), large leakage current (1), relatively low energy density c... (1), still very expensive (1)
- Applications (200)**: energy storage (22), place of battery (19), as electric energy storage u... (15), as energy storage device (12), application (11), addition to battery (11), power plant (9), electrical path (9), as power source (8), Vehicle (8)
- Conditions (45)**: maintenance (8), voltage (5), voltage range of 1.8 to 2.2 Vo... (5), temperature (2), equipment (2), no maintenance (2), recharging (2), relatively low voltage (2), operating voltage range of 1.... (1), current (1)
- Locations (87)**: in sery (7), in electrolyte material (6), in condition (6), in electrode material (6), in Hybrid Electric Vehicle (5), in parallel (5), in electric vehicle (3), on DC link (3), in urban rail car (2), on low side (2)

At the bottom, there are buttons for "Save Solutions", "Export", "Previous", and "Next".

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# Semantic Technology Software Steps

The screenshot shows a software interface for semantic technology research. The main window has a toolbar at the top with File, Edit, View, Tools, Report, Help, and various icons. Below the toolbar is a menu bar with Dashboard, Tasks, Researcher, and Project Explorer. The Researcher tab is selected. A central search bar displays the query "As Natural Language EN Ultracapacitors" and a "Find" button. A yellow box highlights the search term "Ultracapacitors". A blue callout box with the text "Expand solution to view detailed results" points to a section of the results. The results are categorized into several boxes:

- Definitions (200)**:
  - third of storage device ... (16)
  - supercapacitor ... (16)
  - energy storage device ... (14)
  - double layer capacitor ... (13)
  - electrochemical capacitor ... (12)
  - electrochemical capacitor b... (9)
  - double-layer capacitor delive... (9)
  - double-layer capacitor ... (8)
  - electrolytic technology capa... (7)
  - depending on application ... (6)
- More Specific (200)**:
  - super ultracapacitor ... (98)
  - internal ultracapacitor ... (42)
  - high power density ultracapa... (2)
  - capacitor ...
  - individual ultracapacitor ...
  - energy storage device ... (25)
  - term 'ultracapacitor' ... (24)
  - HIGH PERFORMANCE ULTRACAPACITOR ... (1)
  - electrochemical u...
  - carbon-based ultr...
- Disadvantages (19)**:
  - typically more expensive than ... (6)
  - more expensive than battery ... (3)
  - loss of full charge in day ... (3)
  - quite expensive around energ... (1)
  - loss of system performance ... (1)
- Applications (200)**:
  - energy storage ...
  - place of battery ...
  - as electric energy ...
  - as energy storage device ... (12)
  - application ... (11)
  - temperature ... (2)
  - equipment ... (2)
  - in electrode material ... (6)
  - in Hybrid Electric Vehicle ... (5)
- Advantages (127)**:
  - more efficient than battery ... (6)
  - rapid rechargeability ... (4)
  - elimination of mechanical deg... (3)
  - good cycle lifetime ... (3)
  - useful for application ... (3)
  - improvement of efficiency of o... (3)
  - improvement of performance ... (3)
  - allowing of SOC ... (3)

A blue callout box with the text "Expand solution to view detailed results" points to the "More Specific" section. A modal window titled "HIGH PERFORMANCE ULTRACAPACITOR" is open, showing the patent "US-20080192407 A1 HIGH PERFORMANCE ULTRACAPACITORS WITH CARBON NANOMATERIALS AND IONIC LIQUIDS". A "Save Solution" button is visible in the bottom right corner of the modal.

# Semantic Technology Software Steps

The screenshot shows a software interface titled "Researcher". The left sidebar has a tree view with "Knowledge Search" selected. The main area shows a search bar with "Query: As Natural Language" and "EN Ultracapacitors" entered, with a "Find" button. A blue callout box points to this search bar with the text "View specific results based on search term". Below the search bar, there's a "Spellchecker: Ultracapacitors" section and a "More Specific (200)" link. The main content area displays search results for "Ultracapacitors", listing three items:

- 1. high performance ultracapacitor**  
The invention relates generally to composite electrodes for electrochemical devices and particularly to carbon nanocomposite electrodes for **high performance ultracapacitors**.  
[US-20090272946 A1 HIGH PERFORMANCE CARBON NANOCOMPOSITES FOR ULTRACAPACITORS](#)  
[15 more results from this document](#)
- 2. high performance ultracapacitor**  
FIELD OF THE INVENTION The invention relates generally to composite electrodes for electrochemical devices and particularly to carbon nanocomposite electrodes for **high performance ultracapacitors**.  
[WO-2009137508 A1 HIGH PERFORMANCE CARBON NANOCOMPOSITES FOR ULTRACAPACITORS](#)  
[15 more results from this document](#)
- 3. HIGH PERFORMANCE ULTRACAPACITOR**  
**HIGH PERFORMANCE ULTRACAPACITORS WITH CARBON NANOMATERIALS AND IONIC LIQUIDS.**  
[US-20080192407 A1 HIGH PERFORMANCE ULTRACAPACITORS WITH CARBON NANOMATERIALS AND IONIC LIQUIDS](#)  
[10 more results from this document](#)

On the right, there's a sidebar titled "Answers" with a list of terms like "All Answers", "super ultracapacitor", "internal ultracapacitor", etc., and a "Topics" section with "All Topics", "ultracapacitor", and "nonaqueous ultracapacitor".

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# Semantic Technology Software Steps

View dynamically generated summaries based on semantic search query

The screenshot shows a software interface for patent search and analysis. At the top, there's a navigation bar with a magnifying glass icon, a dropdown menu, and a search input field. Below it, a toolbar includes icons for search, refresh, and help. The main area has tabs for 'Search' (selected), 'Analysis', 'Compare', and 'Report'. A sidebar on the left lists categories: Publication Number, Title, Application, Task, Method, and Features. The 'Title' tab is selected, displaying the title 'HIGH PERFORMANCE ULTRACAPACITORS WITH CARBON NANOMATERIALS AND IONIC LIQUIDS'. The 'Task' section contains a single sentence. The 'Method' section describes a process involving etching CNTs. The 'Features' section is expanded, showing a detailed description of the invention, mentioning aligned CNTs, ionic liquids, and their benefits. A diagram of a capacitor structure is shown below the features. A large blue callout box on the right side points to the 'Features' section, containing the text 'View dynamically generated summaries based on semantic search query'. To the right of the callout, a smaller window shows a summary of the features.

Publication Number: US-20080192407 A1

Title: HIGH PERFORMANCE ULTRACAPACITORS WITH CARBON NANOMATERIALS AND IONIC LIQUIDS

Application:

Task: There is thus a need for an ultracapacitor capable of providing high energy and power densities, safe operation, and long cycle lives.

Method: To provide optimal results, the ends or tips of the CNTs are preferably removed by etching to "open up" the interior of the CNTs to the electrolyte thereby effectively doubling the electrolyte-accessible surface area of the CNT-based electrode.

Features: The combination of the unique properties of aligned CNTs (e.g., high electrical conductivity, high specific surface area, high charge transport and high electrolyte accessibility) as electrodes with the unique properties of environmentally friendly ionic liquids (e.g., high ionic conductivity, electrochemical window, excellent thermal stability, non-volatility, non-flammability, non-toxicity, and negligible electrolyte depletion) as electrolytes can overcome the limitations of currently available ultracapacitors, achieve high performance and long cycle life, and are capable of delivering high power pulses that can satisfy the requirements for Hybrid Electric Vehicles (HEVs).

Perpendicularly aligned CNTs can provide an enhanced specific surface area, improved charge transport capability, and excellent electrolyte accessibility, making them ideal electrode materials for high performance ultracapacitors. Environmentally stable ionic liquids can have attractive properties, including high ionic conductivity, large electrochemical window, excellent thermal and chemical stability, non-volatility, non-flammability, non-toxicity, and negligible electrolyte depletion and are readily combinable with well-developed Gel Polymer Electrolyte (GPE) technology to environmentally friendly, solid-state, Ionic Liquid-incorporated, Gel Polymer Electrolyte (ILGPE). Being solid-state, ILGPEs can possess distinct advantages over conventional GPEs, such as higher ionic conductivity, better mechanical stability, and longer cycle life.

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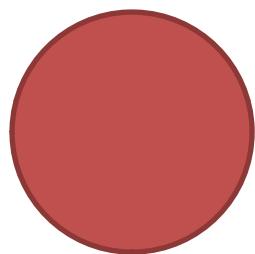
# Semantic Search Knowledge Mining Versus Popular Internet Search Engine

Popular Internet Search	Semantic Search
<ul style="list-style-type: none"><li>- Information resides on internet company's servers.</li><li>- Does not generate summaries</li><li>- Requires subscription to databases, for access to articles.</li></ul>	<ul style="list-style-type: none"><li>- Accesses both structured and unstructured databases.</li><li>- Does not require actual subscription.</li><li>- Yields dynamic summaries</li><li>- Accesses multi-language databases.</li><li>- Virtual SME</li><li>- Software helps to formulate the semantic search questions.</li></ul>

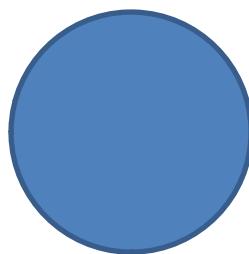
# Implementation to Knowledge Mining, Assessment, and Forecasting Method for DELPHI and Software

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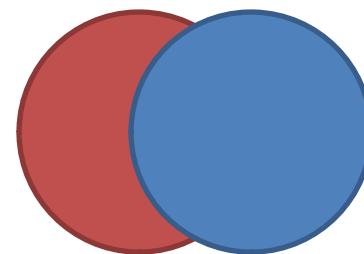
- Both DELPHI and Semantic Searches - Expected Results



**Case 1**

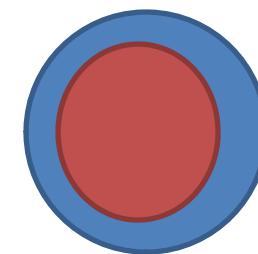


OR



**Case 2**

OR



**Case 3**

Red = DELPHI Method

Blue = Semantic Search Method

# Technology Assessment Board (TAB)

## - Case Study

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- XYZ, Inc. seeks Capital Investment Proposal
- **Proposal** from Hot Shot Scientist – Miniaturized Communication Antenna using Super-Conducting Materials.
  - Traditional Approach
  - Scientist briefs Corporate Board of Directors and requests \$10 Million.
  - Board's Response and Questions – None, since they understood nothing on the technology.
  - Funding unanimously granted, since proposal sounded hi-tech
  - Funding not based on sound scientific principles

# TAB Composition for the Miniaturized Superconducting Communications Antenna

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- Basic Physicist for Superconductivity
- Ceramics Engineer for the Superconducting Materials
- Cryogenics Expert – Material Sciences
- Communications Specialist with Army Background
- System Integrator
- NASA
- Partners to Transition Technology to the Commercial World Applications.

*Truly a Diverse, based on VIRTUAL SME, Technology Assessment Board (TAB) to Cost-Effectively decide Science based Investment Decision*

# Implementation Challenges and Mitigation Approach

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- It is one thing to invent and another to disseminate
- Many people do not like **CHANGE**
- Each System encompasses Multiple Sciences and Engineering Disciplines
  - Multi-disciplinary TABs
- Technology is Rapidly Changing throughout the World
  - Semantic search will help

# Implementation Challenges and Mitigation Approach

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- Limited Budgetary Resources with Multiple Technologies Competing for the same.
  - TARDEC strategy to combine software semantic search with TAB
- Experienced Personnel in Military Systems Development Exponentially Decreasing through Retirements.
  - Employ young minds through a Co-op Program / SMART Scholars
- Pros and Cons of Central versus De-centralized Resident Experts in Knowledge/Data Mining within TARDEC.
  - Take one step at a time to enable and excite user market

## Current Status

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- Semantic Search based COTS software under Acquisition.
- Disseminate Program at every available opportunity.
- It seems the job was specifically created for me
- It seems that I was born to contribute my mite to technology.

# Acknowledgements

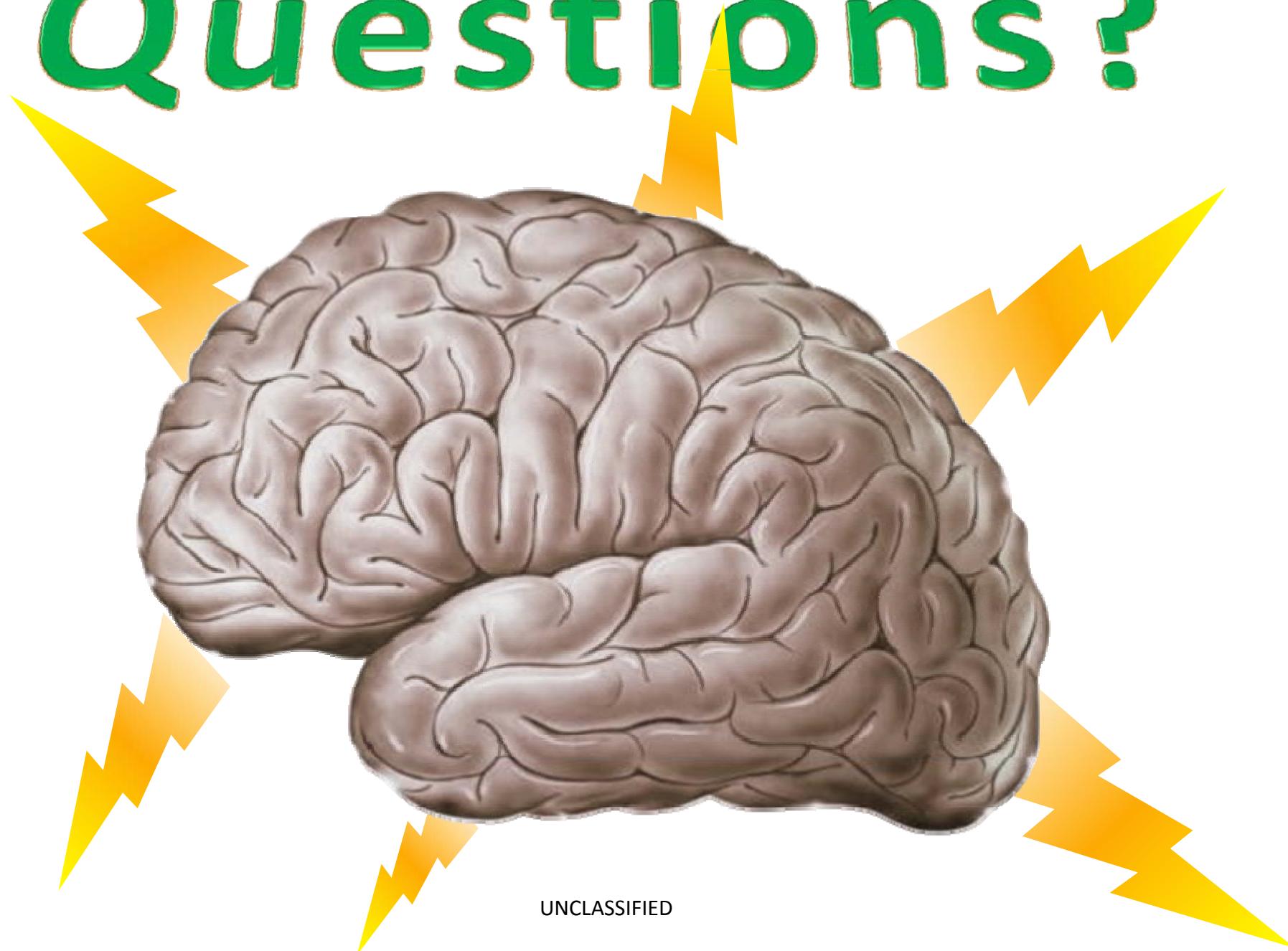
**Thank you for your participation**

Special thanks to:



**Jack Daniels, PhD, PE, CPE, FASCE, FIEE, FPE, FSAE, FSE, FSS, FPEI**  
Technology and Innovation at a leading U.S. university

# Questions?



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# Disclaimer

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